PROGRESS REPORTS

FROM

EXPERIMENT STATIONS

SEASON 1959-60

TANGANYIKA TERRITORY
LAKE PROVINCE

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TANGANYIKA TERRITORY
LAKE PROVINCE

PROGRESS REPORT FOR THE SEASON 1959-60

COTTON SEASON

Sowing: Ukiriguru, late November to end December 1959.
Picking: Ukiriguru, mid April to mid July 1959.
Rainfall, 1st October 1959 to 30th June 1960: Ukiriguru, 32·17 inches.

INTRODUCTION

BY

G. M. WICKENS

Western Region Research Centre, Ukiriguru

Staff.—Mr. and Mrs. M. H. Arnold were on leave from 23rd May to 9th September. Mr. A. M. Kabaara returned from his two-year studentship at Aberdeen University, where he gained the degree of M.Sc., on 10th November. From 11th April to 5th November Dr. G. M. Wickens was in charge of the Research Centre.

In March, Mr. Arnold attended a meeting of the Specialist Committee for Agricultural Botany in Arusha. Mr. K. J. Brown attended a soil fertility conference in Uganda in April, and examined the possibilities of cotton growing in Bukoba District in June. Dr. Wickens visited Ilonga and cotton districts in the Eastern Province in May, and Namulonge in November.

General.—Good early rains permitted early sowing and establishment. Thereafter until towards the end of April, distribution was good, with temperatures rather lower and relative humidity rather higher than the 1946-59 averages. The rains then suddenly ceased, abnormally early, and in May and June temperatures were higher and relative humidity lower than average. Consequently the crop opened rapidly, and picking was completed by the middle of July. A sharp attack of American bollworm in some of the experiments—to be expected with maize sown early in nearby peasant holdings—required treatment with insecticide.

Similar weather prevailed generally in Sukumaland South and North Districts. In the former, according to a Department of Agriculture analysis, the crop was the largest ever produced, and in the latter it was about the same as in the previous year. In the East Lake Division, however, rainfall was heavy, being about double the average, and the crop was only about half of that of the previous year.

TABLE 1

METEOROLOGICAL DATA, UKIRIGURU, OCTOBER 1959 TO SEPTEMBER 1960
WITH MEANS OF PREVIOUS SEASONS

Month	*Rainfall (inches)*		*Days rain*		*Relative humidity %*				*Maximum temperature °F (screen)*		*Minimum temperature °F (screen)*		*Sunshine daily mean hours*
	1959-60	1931-60	1959-60	1931-60	1959-60 9 a.m.	1959-60 3 p.m.	1946-59 9 am.	1946-59 3 p.m.	1959-60	1946-59	1959-60	1946-59	1959-60 *
October	3·11	1·47	6	5·5	81	47	62	40	82·9	86·4	65·7	65·4	—
November	4·83	3·85	13	11·8	83	58	72	49	81·7	83·8	65·5	65·7	—
December	2·42	4·08	8	12·5	81	54	78	54	81·3	82·0	64·4	64·7	—
January	4·08	3·71	13	10·4	84	68	80	52	80·5	82·9	64·0	64·5	—
February	4·03	3·32	13	9·6	77	54	76	51	82·1	83·6	64·2	64·7	6·8
March	7·09	4·82	12	12·9	87	65	80	51	80·6	83·6	64·1	64·8	4·9
April	6·55	5·50	12	14·7	80	61	79	58	81·4	82·2	63·9	64·3	7·8
May	0·06	2·73	1	9·3	67	45	80	54	84·0	82·1	63·2	63·5	9·2
June	0·00	0·40	0	1·9	70	40	73	44	84·2	83·3	60·2	60·8	10·3
July	0·00	0·04	0	0·4	75	42	67	39	83·1	83·8	58·5	59·7	9·7
August	0·00	0·39	0	1·9	60	32	67	40	85·3	84·4	61·5	61·7	9·2
September	0·48	0·90	4	3·3	58	38	64	41	85·4	86·0	64·1	64·2	6·7
Totals	32·65	31·21	82	94·2	—	—	—	—	—	—	—	—	—
Means	—	—	—	—	75	50	73	48	82·7	83·7	63·3	63·7	—

*Campbell-Stokes sunshine recorder, no records available until February 1960.

The net result was a Lake Province crop of only about 163,000 bales, a big disappointment as about 220,000 bales had been excepted.

The report on cotton breeding clearly brings out the advantages of the newer seed issues to Lake Province cotton production. Doubts concerning inherent quality characteristics of Uk55 have been resolved, and it is expected that multiplication of this as well as of Uk58 will now proceed at the greatest possible rate. An Albar hybrid seed issue, hoped for in 1961, should further stabilize and increase production by the virtual elimination of bacterial blight as a fluctuating limiting factor.

In the fields of agronomy and crop physiology, emphasis is on the study of growth and cropping characteristics of Albar hybrids, as an aid to the formulation of seed issues with wide adaptability to varying climate. Work is also continuing on timing and method of application of nitrogen against the time when, it is hoped, there will be wide understanding of the economic benefits obtainable from fertilizer use. Increasing interest is already evident. Growing use of ox and mechanical cultivation points the need for continuing to examine in all respects the suitability for cotton of 3 ft ridges, as compared with the present standard 5 ft ridges.

Work on bacterial blight is being rounded off. The outstanding question is that of finding the most economic method of seed treatment, consonant with efficiency and safety to the operators. During this season, in co-operation with Department of Agriculture, Lint and Seed Marketing Board, a local ginnery and Plant Protection Limited, trials of mercurial compounds have been made in one of the new continuous feed machines. The main purpose was to study safety to the operators; final results are awaited. To minimise the chance that a new race of *Xanthomonas malvacearum* may arise capable of overcoming the resistance of the Albar hybrids seed dressing will have to continue.

Study of Fusarium wilt was continued by Dr. D. A. Perry at Namulonge. The disease continues to spread in Geita District, and was found for the first time at places on the E. side of Mwanza Gulf and Smith Sound. The main reason for having this work centred on Namulonge has thus disappeared, and it will now be centred on Ukiriguru.

Verticillium wilt has been diagnosed in plants collected in E. Province (Ulaya) and in plants received from N. Province (Arusha District). According to reports, the disease is fairly extensive in the latter district. The wilt disease in S. Sukumaland (Lake Province) has still defied diagnosis. Future work will embrace all these occurrences.

Cotton Breeding

BY

M. H. ARNOLD and K. J. BROWN

The cotton breeding programme continued along the lines described in last season's report. In the main variety trials at Ukiriguru, Lubaga and the district plots the mean yield increases from the new seed issues, compared with Mz561, were considerably greater than the averages for the past five seasons. Since the whole scatter of these trials approximates to a random sample of the cotton producing area, the results, shown in Table 2, may be taken to illustrate the

Table 2

Performance of seed issues relative to Mz561 over all main variety trials

	Means of 17 trials—1960			*Means of 66 trials—1955-1959*		
Seed issue	*Lint lb per acre*	*% Mz561*	*Ginning percentage*	*Lint lb per acre*	*% Mz561*	*Ginning percentage*
Mz561	181	100	32·2	285	100	32·5
Uk51	251	139	33·7	335	118	33·6
Uk55	276	152	35·0	364	128	34·7
Uk58	281	155	35·1	—	—	—

contribution of the seed issues to increased production. Not only were the yield levels of the new issues higher, but in a season in which yields were generally low, the new issues suffered less than Mz561. Whilst the mean lint yields of Uk51 and Uk55 fell short of the average for the previous five years by 25%, the figure for Mz561 was 37%. It is interesting to note that the total Lake Province crop of 163,000 bales fell short of the original estimate by 26%. This estimate was based on the average return of Uk51 from a given amount of seed distributed and the shortfall agrees very closely with that measured in the variety trials.

Part of the greater stability of yield of the more recent seed issues can be attributed to jassid resistance. Jassid attack was prevalent throughout the southern parts of the Province, and in Table 3 are

Table 3

Performance of new seed issues relative to Uk51 under severe jassid attack

	Yield of lint lb per acre			*Means*	
	Lubaga		*Mabuki*	*Lint*	*%*
Seed issue	*Trial A*	*Trial B*		*lb per acre*	*Uk51*
Mz561	90	87	25	67	37
Uk51	215	206	127	183	100
Uk55	300	256	215	257	140
Uk58	311	257	203	257	140
S.E.	±19·0	±17·6	±15·0		

shown the results from three trials where the attack was severe. In these trials, the enhanced resistance of Uk55 and Uk58 compared with Uk51 was clearly visible, whilst Uk51 itself showed a very great improvement over Mz561. These differences correspond with the differences in yield.

In all, 42 Albar hybrid strains were tested in main variety trials, the trials being divided into two groups for this purpose. In Table 4

TABLE 4

PERFORMANCE OF SELECTED ALBAR HYBRIDS RELATIVE TO UK58 IN MAIN VARIETY TRIALS

Strain	*Lint lb per acre*	*% Uk58*	*Ginning percentage*
Group 'A'—means of 8 trials			
Uk58	308	100	35·1
121/I6/382	335	109	37·1
121/I7/174	331	107	37·4
178	310	101	36·4
180	324	105	37·5
Group 'B'—means of 7 trials			
Uk58	325	100	35·1
E21/I7/716	347	107	34·8
718	351	108	35·0
G2.1/I7/904	321	99	35·2
908	325	100	34·4
67/I7/51	386	119	37·9
68	376	116	36·6
86	406	131	37·4
101	311	96	35·8
103	340	105	37·1

are shown the yields for the more important families, re-selections from which will be tested in the coming season for possible inclusion in a Uk61 seed issue. The yield level now achieved in these hybrid strains must be considered entirely satisfactory, since all main variety trials are carried out under conditions of minimal attack by bacterial blight, the seed being acid delinted. With the Ukiriguru strains, seed-borne infection is reduced to a very low level by acid delinting, whilst with the Albar hybrids it is virtually eliminated. Thus in these trials, which now comprise chiefly Albar hybrids, there is little opportunity for bacterial blight to build up to epidemic proportions even in the susceptible strains. An indication of the yield advances from resistant

strains in the presence of the disease is given in the Bacterial Blight section of this report.

The figures in Table 4 also show the high ginning percentages of many of the Albar hybrids, some of which show advances of more than 2% over Uk58.

Variations in lint quality in the Albar hybrids have been reported elsewhere (Arnold, 1960). From the continuous range of qualities available between the more extreme types, it should be possible to constitute a seed issue which will satisfy the immediate requirements of the industry and plans are now being made, in consultation with the Department of Agriculture and the Lint & Seed Marketing Board, for a first multiplication of Albar hybrid seed during the 1961-62 season.

Agronomy and Crop Physiology

BY

K. J. BROWN

Highly Fertilized and Exhaustion Plots

Yields are given in Table 5 of the highly fertilized and unfertilized plots in a long-standing experiment which included an exhaustion plot cropped with cotton continuously for nineteen years.

Table 5

Yields of exhaustion plots: trial 25 Machafu

Year	*Mean seed cotton yield in lb per acre*	
	"High Field"	*Exhaustion plot*
1957-59 (3 year average)	1811	489
1959-60	1828	378

The results this season were similar to the 3-year average although the "High Field" did not realise as much as in some years; yields of over 2,000 lb per acre have been recorded. The exhaustion plot gave less than average because of a substantial nitrogen deficiency to be mentioned later.

NPD Experiment

Three different applications of sulphate of ammonia were compared with no added inorganic nitrogen in the presence and absence of

compost and phosphate. The yields are set out in Table 6; large responses were obtained to sulphate of ammonia this season, but placing this below the ridges before sowing gave a smaller increase than topdressing at flowering time. This was attributed to rapid leaching of available nitrates by early rains when the crop was insufficiently developed to make full use of the nitrogen.

TABLE 6

YIELDS OF NPD EXPERIMENT: TRIAL 26 NYASHIMBA

(1) = No compost or phosphate
D = Six tons of compost per acre
P = 150 lb of double superphosphate per acre
DP = Compost plus superphosphate

Treatment	*Seed cotton yields in lb per acre*					
	(1)	D	P	DP	*Mean*	*Mean increase over control*
No nitrogen	299	754	386	949	597	
100 lb sulphate of ammonia before sowing	499	969	676	1121	816	+219
100 lb sulphate of ammonia top dressed	658	1125	754	1320	964	+367
200 lb sulphate of ammonia top dressed	626	1221	931	1465	1061	+464
Mean	520	1017	687	1214		

Standard errors

Body of table	±89·6
Nitrogen means	±34·1
Phosphate and compost means	±47·9

Closer examination of the yield data comparing the two times of application in the presence and absence of phosphate shows that the losses due to leaching are rather less in the presence of phosphate than in its absence. This indicates a better utilization of the nitrates where phosphate is present, and confirms previous findings.

Growth analyses on Trial 26 supplemented the yield data and gave confirmation of last year's findings that top dressings of a nitrogen fertiliser did not result in an effective increase in plant growth until 3-4 weeks after application. In contrast to the 1958-59 season there was adequate rainfall this season after the fertiliser was applied.

An investigation was started to compare the normal plant population with a 50% increase by varying the spacing between stands. Preliminary analyses of the data show that yields remain constant. There was a reduction in leaf area and dry weight per stand in the higher population, although the leaf area index and the total dry weight of plant material per acre remained the same.

In view of the trend towards tractor and ox-drawn equipment for ridging on the hill sands, the size of ridge may be reduced considerably in the future. The population experiment mentioned above will be redesigned in the 1960-61 season to incorporate 3 and 5 ft ridges. A nitrogen treatment is to be superimposed to see if a more rapid leaf cover can be achieved on the smaller ridge compared with the standard 5 ft ridge.

Physiological studies are continuing on the cropping habits of selections from the Albar hybrid programme. In this season with a very sharp cut-off of the May rains a very early maturing hybrid outyielded the standard variety by 7%, whereas in the previous two seasons it had yielded considerably less than the standard. These studies are necessary in determining the composition of future seed issues, as a proportion of earlier maturing types could well be included as an insurance against the shorter season.

Recent seed issues have tended to become later maturing, taking full advantage of the long growing season. The present investigations are aimed at determining the point at which this could become detrimental. In some years Uk55 has set up to thirty per cent. of its bolls from May flowers, and this season most of these were lost.

Bacterial Blight

BY

M. H. and K. M. ARNOLD

Work on Resistant Strains

In continuation of the studies on the effect of bacterial blight on yield, further variety trials were laid down in which the level of bacterial blight was varied by seed treatment and by staggering sowing dates so that the seed emerged under varying conditions. In no case did the disease develop as aggressively as in the previous season and it seems likely that this was associated with generally lower temperatures over the main part of the growing season.

The Albar hybrid E21/I5/504 gave practically the same yield as Uk51 when disease attack was minimal and 9%, 14% and 20% more

with increasing levels of attack. In contrast to last season's results, the effect of the disease on the proportion of grade C seed cotton harvested was very small.

Inoculation trials were continued in order to study the variability for resistance in Albar hybrids as well as amongst reselections from basic Ukiriguru stocks. In all, five 25-strain balanced lattice trials were completed both for stem resistance and for boll resistance. In addition to providing essential information for the breeding programme, these experiments are laying the foundations for more intensive studies on the genetics of resistance which it is hoped will be developed.

Seed Treatment

Seed treatment trials were concerned mainly with testing the efficiency of seed dressing under commercial conditions, using Abavit B in Booth drums and Agrosan GN in the prototype Plant Protection machine. Results showed that for both processes, infection levels were consistently less than 2% (being less than 1% in all cases except one) compared with levels of 24% to 51% in untreated samples. This represents a very satisfactory degree of control.

Assistance was given to the Department of Agriculture in carrying out a large scale experiment on the possible dangers to operators in the industrial use of mercurial dressings. Full results of this experiment are not yet available.

Trash-borne Infection

Examination of samples from fields at Ukiriguru and from nearby peasant holdings showed that *Xanthomonas* was present in a pathogenic state in early November when cultivation started. Compost made mainly from cotton stalks was being applied at that time, but in this the organism was not found in dangerous quantity.

More detailed work was designed to follow up the results obtained last season, with studies on the survival of *Xanthomonas* in cotton trash on the surface and at varying depths in both hill sand and valley bottom (*mbuga*) soils. The inferences of practical importance to be drawn from this work may be briefly stated as follows. Provided that the trash from a previous crop is buried, either by ridging or ploughing, there is little likelihood that the pathogen will cause significant infection of an ensuing crop, on either soil type. Where little pre-sowing cultivation is practised, as on some *mbugas,* trash-borne infection will be at a low level provided the *mbuga* has been subjected to periodic wetting by from three to six inches of rainfall for a period of one month before planting.

Fusarium Wilt of Cotton

BY

D. A. PERRY (Namulonge, Uganda)

Introduction

Studies on Fusarium wilt of cotton in the Lake Province of Tanganyika in the season 1959-60 followed the same lines as in the previous season. The survey of the numbers of shambas affected by wilt was continued by staff of the Department of Agriculture and experimental work was done at Rugongo. Throughout the season, close liaison was maintained with Mr. W. G. Mathewson, Agricultural Officer, Geita. Several visits were made to the area during the season to supervise both the survey and the experimental work and to see the disease in the field.

Wilt Survey Results

Throughout the district the disease appeared less severe than last season but as the survey figures show, more shambas were affected. Environmental conditions affect the expression of the disease and it is suggested that although the season was unfavourable for the development of the disease within a plant, it did not prevent its spread.

When all reasonable allowances are made for incompleteness of some of the surveys, there can be no doubt that wilt has been steadily increasing, and that the disease has extended to areas some miles inland from the Lake shore. In Buchosa outbreaks were reported from Kishinda and Nyangongochoro inland, and wilt was also found for the first time in Kagu, on the extreme east of the district. Five outbreaks were found in the Mwanza Chiefdom and two in the Bulima Chiefdom. Mwanza and Bulima are on the eastern side of Mwanza Gulf, so Fusarium wilt is not now confined to Geita District. Samples of wilted plants were obtained from all these newly recorded points and examined at Namulonge. *F. oxysporum* was isolated from all of them.

Table 7

Results of Fusarium wilt surveys for the past three years

Chiefdom	*No. of growers 1958*	*No. of shambas with wilt*		
		1958	*1959*	*1960*
Karumo	7,356	160	155*	291
Buchosa	12,643	106	281	298*
Mwanza		0	0	5
Bulima		0	0	2
Totals		266	436	596†

* Survey in some areas known to have been incomplete.

† In addition, 49 shambas infected in the previous year were not planted to cotton 1959-60.

Additional information obtained in the survey showed that the intensity of the disease on a shamba was correlated with the number of years that cotton had been grown on that shamba (Table 8). There was, however, considerable variation; for example, a slight attack was found on a shamba that had been continuously cropped with cotton for 9 years and one moderate attack was found on land in the first year of cotton cultivation.

TABLE 8

THE RELATIONSHIP BETWEEN INTENSITY OF COTTON WILT AND THE NUMBER OF YEARS CONTINUOUS COTTON GROWING IN KARUMO

Disease intensity	*Average number of years cotton grown*	*Range*	*No. of samples*
Slight	3·39	1- 9	143
Moderate	5·49	1-15	144
Severe	6·75	4- 9	4

Slight—occasional wilted plant in a shamba.
Moderate—up to half the plants in a shamba wilted.
Severe—more than half the plants in a shamba wilted.

Cotton wilt was found to be most prevalent on poor *lusenyi* soil (grey sandy soil), and less prevalent on *isanga* (very sandy lake shore soil) and on clay soil.

Cotton root-knot eelworm was found to be associated with 53% of the total wilt outbreaks and, when severity of attack was considered, the proportion of the attacks associated with eelworm increased as the severity increased.

Evidence was also obtained to show that eelworm was more frequent in land on which cotton had been grown continuously for several years but no information was obtained concerning the distribution of root-knot eelworm in the absence of wilt.

Seed-borne Infection of F. oxysporum

Seed cotton was collected from a severely affected shamba in 1959 and examined for the presence of *F. oxysporum*. The seeds were acid delinted and put to germinate in a damp chamber. Any fungi that grew on the seedlings were sub-cultured and identified. Of 1,000 seeds tested in this way, two were found to be infected with *F. oxysporum*.

In 1960, seeds taken from infected plants in which discoloration extended into the vascular system of the bolls were delinted and surface sterilised. *Fusarium oxysporum* grew from 46% of these seeds when they were planted out on agar and of 5 isolates selected at random, all were pathogenic to cotton. When sown in soil many of the seeds rotted and failed to germinate.

The percentage of infected seeds found in this second experiment was far higher than would be expected in a bulk of seed from an infected shamba, because the bolls were specially selected. The first experiment in which 0·2% of the seeds were found to be infected probably represents a more normal rate of seed-borne infection.

These experiments show conclusively that the fungus does enter seeds and even if such seeds fail to germinate in the field they are a source of inoculum to healthy plants, particularly those in the same hole.

Selection for Resistance to Fusarium Wilt

Twelve strains of cotton selected at Ukiriguru for characters other than wilt resistance were planted in non-replicated ridges on infested land at Rugongo. Sixty-four plants of each strain were grown on a ridge and Uk51 was grown on every alternate ridge as an indicator of the presence of wilt in the soil.

Results are given in Table 9, in which plants apparently healthy at the end of the season are expressed as percentage of total plants.

Table 9

Survival of plants in twelve strains exposed to Fusarium wilt at Rugongo

Plot A		*Plot B*		*Plot C*	
Variety	*% survival*	*Variety*	*% survival*	*Variety*	*% survival*
Uk51	98·5	Uk51	9·4	Uk51	39·2
67/I6/431	98·5	67/I7/101	26·2	67/I7/105	42·9
Uk51	90·5	Uk51	13·3	Uk51	25·9
Uk55	89·4	67/I7/102	11·9	67/I7/106	48·3
Uk51	78·5	Uk51	12·3	Uk51	37·5
Pan B	87·7	67/I7/103	18·7	67/I6/431	62·7
Uk51	76·5	Uk51	15·9	Uk51	51·4
G2.1/I7/910	90·2	67/I7/104	15·2	G2.1/I7/894	62·3
Uk51	59·3	Uk51	17·6	Uk51	36·2

The percentages of wilted plants in the indicator rows of Uk51 show that there was considerable variation in the degree of soil infestation although the plots were close together. It appears that there were no highly resistant strains amongst those tested but possibly some were appreciably more resistant than Uk51 and with continuous intense selection for resistance these may provide a source of suitable breeding material.

Reference

Arnold, M. H. (1960). "Lint quality in Lake Province cottons of the future". *Emp. Cott. Gr. Rev., 37,* 178-181.

Appendix

Origin and Special Characteristics of the Main Cotton Strains Mentioned

Local	A mixture of Upland types introduced into the Lake Province from the turn of the century onwards—mainly from Uganda and Nyasaland.
Mz561	A straight selection from Mwanza Local, first multiplied in the 1939-40 season.
Uk51	A multiline seed issue incorporating strains with jassid resistance, first multiplied in the 1951-52 season.
Uk55	A multiline seed issue composed of 0/334 and 1/667 strains outstanding for yield and jassid resistance. First multiplied in the 1955-56 season.
Uk58	A multiline seed issue of selections from 0/334 and 1/667. First multiplied in the 1958-59 season.
Albar	Nigerian Allen (A1) blackarm resistance (bar) selections made at Namulonge. Two series of selections were made independently, Albar 49 in 1949 and Albar 51 in 1951.
Albar hybrids	A general term embracing selections derived from crosses between Albar 51 and strains of Lake Province Local origin, backcrossed to the locally adapted type. The trinomial designation of each selection comprises (i) a reference to the crossing history (see below), (ii) the year of selection (e.g. I5 being "in-season 1955"), and (iii) the serial number of the selections. 67, 121 } 1st backcross derivatives. E21, G2.1 } 3rd backcross derivatives.
Pan B	A mixture of Albar hybrids which had been grown in panmixis for 3 generations.

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PROGRESS REPORTS FROM EXPERIMENT STATIONS

The reports for the seasons up to and including 1950-51 were published in seasonal volumes; the following are still in print and available at 3/- per volume post free.

1923-25 (one volume), 1926-27, 1931-32, 1934-35,
1935-36, 1942-43 and 1945-46 to 1950-51.

From 1951-52 the reports from each territory were published individually each season. A few of the 1951-52 reports are out of print, but all others are available post free at 2/6 per report or £1 for the seasonal set.